Use of Cellulose Nanofibers as a Denture Immersing Solution

論 文 内 容 要 旨

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Background:

Increase in the number of elderly persons will lead to increased demands of dental prosthetics with regard to tooth loss, even supposing that intensive oral care may protect them from tooth loss. Removable appliances are most commonly used for oral rehabilitation in edentulous patients. The chewing force is equally distributed to the alveolar membrane and bone by the base of the dental prosthesis. Improvements in the properties of denture base materials can contribute to the restoration of oral functions, which in turn may upgrade of the quality of life (QOL) in aged denture wearers. Polymethyl methacrylate (PMMA), a polymer-based material introduced in the 1930s, has been most commonly used for the fabrication of dentures.

For the removable denture to function well in the oral cavity, retention and stability are of utmost importance. Surface wettability of the denture base material is the most important factor for denture retention. However, PMMA is known for its hydrophobic nature. The most important factor for achieving retention in complete dentures is the accurate fit of the denture in the oral cavity resulting in a perfect border seal.

A major factor involved in the retention of a well-adapted denture is the force related to the wetting of the denture and the mucosal surfaces. Some researchers suggested that increasing the wettability of the mucosal surface might improve denture retention. Measurements of contact angles have been utilized to estimate the wettability of different materials. The higher the contact angle, the poorer the wettability of the material. The wettability of dental materials is vital because it indicates the ease by which saliva spreads over the surfaces.

Cellulose from plants and microorganisms is non-toxic, plentiful, renewable and sustainable. Owing to superior physical properties such as high mechanical strength, low thermal expansion, high aspect ratios, and transparency, cellulose nanofibers (CNF) can be used as an innovative biomass material in many fields. Moreover, CNF possess superior hydrophilic properties. Therefore, the coating of the surface of a PMMA denture base with CNF might improve its surface wettability and enhance the denture retention in the oral cavity.

Purpose:

The purpose of this study was to investigate the influence of cellulose nanofibers (CNF) solution on the mechanical and biological properties of denture base resins. Our hypothesis is that CNF can be utilized as a solution in which, the denture can be immersed in order to improve its surface wettability.

Methods:

Two types of CNFs obtained from bamboo (BB) and needle-leaved (NB) trees were used in this study. We prepared 18 different CNF solutions based on their fibrillation (A-low, B-middle, and C-high) and concentration (0.05 wt%, 0.10 wt%, and 0.20 wt%). A heat-polymerized acrylic resin was used as denture base material. Specimens immersed in distilled water formed the controls, while those that were not immersed in any solution belonged to the blank group. The contact angles for each specimen in all groups were measured after 0, 7, 14, 28, 56, 70, 84, 98, 112, 126, 140, 154, and 168 days of immersion. Additionally, the flexural properties of the specimens after immersion, and the cytotoxic and antimicrobial properties of the CNF solutions were examined.

Results:

Specimens immersed in CNF-NB-C (0.05 wt%) solution presented with the lowest contact angles when compared with those in other groups. Specimens in the CNF-NB-C and the CNF-BB-A groups (concentration of 0.05 wt% and 0.1 wt%) showed higher flexural modulus values when compared with those in the other groups. No cytotoxic or antimicrobial effects were observed for the CNF solutions.

Conclusions:

The findings of this study suggest that immersion of the denture in CNF solution may improve the surface wettability of the denture base resin without affecting its flexural property.